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A REFRIGERATION UNIT

THIS INVENTION relates to refrigeration. It more particularly relates to a method of refrigerating an item, and to a refrigeration unit.

The Applicant is of the opinion that the invention will particularly advantageously be applicable to rapid refrigeration of items, and that application will particularly be borne in mind for purposes of this specification. Naturally, however, the invention may be used in other applications.

In accordance with one aspect of the invention, there is provided a method of refrigerating an item, which method includes

cooling a working fluid to a temperature lower than that of an item to be refrigerated;

dispensing the cooled working fluid onto the item thereby, on account of heat exchange between the working fluid and the item, extracting heat from the item to refrigerate the item; and

collecting the dispensed working fluid for re-use.

The working fluid may be cooled to a predetermined temperature and may be continuously dispensed onto the item for a time required to refrigerate the item to a desired temperature.

Dispensing of the working fluid onto the item may be by spraying it onto the item.

Collection of the dispensed working fluid may be by collecting it under the influence of gravity by means of catchment means.

The method may be executed in a substantially enclosed refrigeration zone with walls defining the enclosed zone forming the catchment means.

Cooling of the working fluid may be by bringing it into direct contact with an evaporator forming part of a closed-loop refrigeration system.

In accordance with another aspect of the invention, there is provided a refrigeration unit which includes

a refrigeration zone for receiving an item or items to be refrigerated;

dispensing means oriented relative to the refrigeration zone so as to enable dispensing of a working fluid into the refrigeration zone; and

catchment means arranged relative to the refrigeration zone so as to collect the working fluid after it has been dispensed into the refrigeration zone.

The refrigeration unit may include cooling means for cooling the working fluid in use.

The refrigeration unit may include a first enclosed compartment, having a sealingly closeable access opening, within which the refrigeration zone is defined, with walls of the compartment forming the catchment means.

The dispensing means may include spraying nozzles located within the first compartment. The spraying nozzles may be mounted on or proximate at least some of the walls of the compartment and may be oriented to direct the working fluid away from their associated walls.

A floor or bottom wall of the first compartment may be apertured to pass working fluid flowing operatively downwardly under the influence of gravity, thereby to direct collected working fluid in use.

The refrigeration unit may include a second enclosed compartment within which the working fluid is received and cooled in use. The second compartment may be in fluid flow communication with the first compartment so as to receive the collected working fluid passing through the aperture or apertures in the bottom wall of the first compartment.

The second compartment may be positioned below the first compartment to permit collected working fluid to flow from the first compartment into the second compartment under the influence of gravity.

The cooling means may include a primary, closed-loop refrigeration system having an operatively interconnected condenser, expansion means, evaporator, and compressor with associated motor, and having an associated refrigerant, with the evaporator being positioned in the second compartment so as to extract heat from the working fluid in the second compartment in use, thereby to cool the working fluid.

The refrigeration unit may include a secondary, closed-loop refrigeration system substantially similar to the primary, closed-loop refrigeration system, with an evaporator of the secondary refrigeration system in heat exchange relationship with the condenser of the primary

refrigeration system thereby to extract heat from the condenser and, hence in use, to enable cooling of the primary refrigeration system refrigerant and, accordingly, the working fluid to lower temperatures.

The refrigeration unit may include a portable housing which houses the components of the or each refrigeration system and within which the first compartment and the second compartment are defined.

The refrigeration unit may include a pump having its inlet in fluid flow communication with the second compartment and its outlet in fluid flow communication with the spraying nozzles. The pump may be activatable so as to pump the working fluid from the second compartment to the spraying nozzles for dispension thereof in use.

The refrigeration unit may include circulation means for circulating the working fluid in the second compartment in use.

At least the first and the second compartments may be thermally insulated.

The invention is now described, by way of example, with reference to the accompanying diagrammatic drawings.

In the drawings:

Figure 1 shows a schematic layout of a refrigeration unit in accordance with the invention;

Figure 2 shows, in part-sectional front view, a refrigeration unit in accordance with the invention; and

Figure 3 shows, in part-sectional top view taken at III-III in Figure 2, the refrigeration unit in accordance with the invention.

With reference to the drawings, a refrigeration unit in accordance with the invention is generally indicated by reference numeral 10. The device 10 includes a parallelepipedal housing 12 defining a first parallelepipedal compartment 14, a second parallelepipedal compartment 16 which is slightly smaller than and located operatively below the first compartment 14, and a third parallelepipedal compartment 18 located operatively alongside the compartments 14, 16.

The first compartment 14 defines a refrigeration zone 20 within which an item or items to be refrigerated is/are receivable. The second compartment 16 defines a reservoir within which a working fluid, e.g. ethanol, which is used to refrigerate the item or items, is receivable and coolable to a temperature below that of the item or items to be refrigerated.

The unit 10 further includes dispensing means, generally indicated by reference numeral 24, oriented relative to the refrigeration zone 20 so as to enable dispensing of the working fluid into the refrigeration zone 20.

The first compartment 14 is defined by a top wall 26, a floor or bottom wall 28 spaced from the top wall 26, opposing side walls 30, 32, a rear wall 34 and an operatively front wall defined by a door 36. The door 36 is hingeably connected to the housing 12 (the hinges are not shown) and when in the open position allows access into the refrigeration zone 20. When in the closed position, the door 36 seals off the compartment 14. The unit 10 may include a latch mechanism (not shown) for sealingly retaining the door 36 in the closed position.

The respective walls defining the first compartment 14, also define catchment means for catching or collecting dispensed working fluid.

The side walls 30,32 and the rear wall 34 extend operatively downwardly to define rear and side walls of the second compartment or reservoir 16. The second compartment is further defined by a front wall (not visible) and a bottom wall or floor 35. Also, with the exception of the side wall 37, walls defining the third compartment 18 are mere extensions of the walls defining the first and second compartments 14, 16.

The respective walls defining the first and second compartments 14, 16 are thermally insulated so as to prevent heat exchange between the interior of the compartments 14, 16 and their surroundings.

The unit 10 further includes cooling means in the form of a primary, closed-loop refrigeration system generally indicated by reference numeral 38.

The dispensing means 24 is constituted by a first array of spraying nozzles 40 and a second array of spraying nozzles 42. The first array of spraying nozzles 40 is mounted on a panel 41 which is secured inside the compartment 40 to an inner face 26.1 of the top wall 26. The panel 41 is of a size substantially similar to that of the inner face 26.1 of the top wall 26 and, if desired, may be embedded into the top wall 26. It is to be appreciated, that the nozzles 40, need not necessarily be mounted on a panel which then, in turn, is mounted to the wall 26 of the compartment 14, but the nozzles 40, can instead be mounted on the wall 26. The second array of spraying nozzles 42 is mounted on an inner face 28.1 of the bottom wall 28.

The nozzles 42 can, however, also be mounted on a panel which then, in turn, is mounted to the bottom wall 28.

The bottom wall 28 includes an array of circular apertures 44 spaced inbetween the nozzles 42. If the nozzles 42 are mounted on a panel, the panel will include circular apertures which are in register with the apertures 44. These apertures 44 provide fluid flow communication between the first compartment 14 and the second compartment or reservoir 16. In Figure 1 the fluid flow communication provided by the apertures 44 is indicated by a fluid flow communication connection 46. The purpose of fluid flow communication between the first compartment 14 and the second compartment or reservoir 16 will become more apparent hereinafter.

The unit 10 further includes a pump 48 having an inlet thereof in fluid flow communication with the second compartment or reservoir 16, and an outlet thereof in fluid flow communication with the respective nozzles 40, 42. The pump 48 has an associated motor (not shown) for driving it in use. In the embodiment shown, however, the pump 48 is located within the reservoir 22. The fluid flow communication between the pump 48 and the respective nozzles 40, 42 is provided by a conduit network, generally indicated by reference numeral 50, and constituted by a conduit 50.1 providing fluid flow communication with the nozzles 42 and a conduit 50.2 providing fluid flow communication with the nozzles 40.

In a variant embodiment (not shown), instead of having a hingeable door 36 providing access into the first compartment 14, the top wall 26 of the first compartment 14 may be a sealingly seated, removable lid. In this embodiment, which will typically be used in smaller applications such as portable refrigeration units, the nozzles 40 will typically be mounted on an underface of the lid, or the panel 41 will be an integral part of the lid. Here, the lid will include a fluid flow connector which, upon closure of the lid will be aligned and sealingly engaged with the conduit 50.2.

Circulation means in the form of a circulation pump 52 is provided within the reservoir 22, in use, to circulate the working fluid within the reservoir 22 to get in proper contact with the evaporator 48 cooling the fluid and evenly to spread the temperature in the working fluid. The pump 52 also has an associated motor (not shown) for driving it in use.

The primary refrigeration system 38 includes a condenser 54, an expander or expansion valve 56, an evaporator 58 and a compressor 60, which respectively are in fluid flow communication via a conduit network, generally indicated by reference numeral 62, to form a closed-loop system. The unit 10 includes also a pump (not shown) for driving the compressor in use. The condenser 54, the expander or expansion valve 56, and the compressor 60 are all located within the third compartment 18. The evaporator 58 is located within the second compartment or reservoir 16. The primary refrigeration system 38 includes also a suitable refrigerant which is circulated within the closed-loop system.

In use, the compressor 60 compresses the refrigerant, which at this point is in vapour form, and feeds it via a conduit 62.1 to the condenser 54 where it is condensed. From the condenser 54 the refrigerant, which is now in liquid form, flows to the expansion valve 56 via a conduit 62.2. In the expansion valve 56, the refrigerant is expanded and from there flows to the evaporator 58, where it is evaporated. On account of the nature of the refrigerant, the evaporation is an endothermic process and heat is thus absorbed from the working fluid within the first compartment or reservoir 16 upon evaporation of the refrigerant. From the evaporator 58 the refrigerant flows, via a conduit 62.4, back to the compressor 60.

In use, the working fluid in the second compartment or reservoir 16 is cooled as hereinbefore described, an item or items to be refrigerated

is located within the first compartment 14, and the cooled working fluid 16 is dispensed, via the nozzles 40, 42, onto the item or items thereby to refrigerate it. Dispensing of the working fluid onto the item or items is effected by actuation of the pump 48. The device 10 will include also an actuator such as a switch, or the like for actuating operation of the pump 48. Upon actuation of the pump 48, it pumps working fluid from the second compartment or reservoir 16 via the conduits 50.1, 50.2 to the respective nozzles 40, 42 by means of which it is dispensed, in droplet form, onto the item or items within the first compartment 14.

The working fluid will typically be cooled to a predetermined temperature and will then be continuously dispensed onto an item or items to be refrigerated for a time required to refrigerate the item or items to a desired temperature. Working fluid dispensed into the first compartment 14 is retained within the first compartment by means of its walls 26, 28, 30, 32, 34 and its door 36. After being dispensed, the working fluid flows toward the floor or bottom wall 28 under gravity and passes through the apertures 44 which, in turn, leads into the second compartment or reservoir 16. The dispensed working fluid is thus collected for re-use.

The device 10 shown in Figure 1 includes also a secondary closed-loop refrigeration system, shown in dotted, generally indicated by reference numeral 64. The secondary refrigeration system 64 is substantially similar to the primary refrigeration system 38. It includes a condenser 66, an expansion valve 68, an evaporator 70, and a compressor 72 with its associated motor, which respectively are in fluid flow communication via a conduit network generally indicated by reference numeral 74. Respective sections of the network 74 are indicated by reference numerals 74.1, 74.2, 74.3, 74.4.

The secondary refrigeration system 64 functions similarly to the primary refrigeration system 38. Here, however, the evaporator 70 is in heat exchange relationship with the condenser 54 of the primary refrigeration system 38 so as, in use, to extract heat from the condenser 54. Preferably, the evaporator 70 and the condenser 54 are located within an insulated casing 76. The primary and the secondary refrigeration systems are thus in combined or cascaded formation. This combined or cascaded refrigeration system enables the primary refrigeration system refrigerant and, hence, the working fluid to be cooled to lower temperatures.

It is an advantage of this invention that it provides a refrigeration device which enables rapid refrigeration of an item or items to relatively low temperatures. It is a further advantage that the working fluid used in the device can be collected and re-used.